CBFO-C99-05

AN ECOLOGICAL ASSESSMENT, USING THE RAPID BIOASSESSMENT PROTOCOL, OF THREE STREAMS DRAINING THE BAINBRIDGE NAVAL TRAINING CENTER, PORT DEPOSIT, MARYLAND

U.S. Fish and Wildlife Service

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Final Report

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Prepared by
Peter C. McGowan
Alfred E. Pinkney
Daniel R. Murphy
and Raymond Y. Li

Under the supervision of
Robert J. Pennington, Assistant Field Supervisor
John P. Wolflin, Field Supervisor

U.S. Fish and Wildlife Service
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

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EXECUTIVE SUMMARY

In 1991 and 1994, the U.S. Department of Defense identified two primary areas of environmental concern, with respect to contaminants, at Bainbridge Naval Training Center (BNTC) located near Port Deposit, Maryland. The Areas of Concern identified were the Old Landfill and the Fire Training Area. Both sites were areas in which hazardous materials and regulated substances had been historically used or stored. The Old Landfill was used for disposal of pesticides, asbestos, and other contaminants from the early 1940s through 1976. The Fire Training Area contained several brick buildings, an oil separator pit, underground vaults and underground storage tanks. Remedial Actions were performed in 1994-95 to remove the sources of contamination.

In 1998, an Ecological Risk Assessment (ERA) was conducted for the two Areas of Concern at BNTC by the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office (CBFO). Results of the ERA suggested that benthos and fish are likely to be at risk in aquatic habitats near the Old Landfill. In addition to the potential risk from chemical contaminants, another threat to the benthic community in streams near the Old Landfill appears to be habitat degradation. The ERA also determined that risks to benthos and fish appear to be unlikely in aquatic habitats draining the Fire Training Area.

Based on the recommendation of the ERA, CBFO conducted a Rapid Bioassessment Protocol (RBP) investigation of three streams draining the Areas of Concern to assess their overall ecological condition. Of the three streams, two drained the Old Landfill and were identified as the East Branch Tributary (EBT) and West Branch Tributary (WBT). A single stream drained the Fire Training Area, and was identified as Happy Valley Branch (HVB).

The RBP results for the stream (HVB) draining the Fire Training Area supported the findings of the 1998 ERA, that risks from contaminants derived from the Fire Training Area to benthos and fish are unlikely. The high RBP scores for physical habitat and benthos at this stream indicated that HVB could have been used as a reference stream for this investigation. It is recommended that future aquatic biomonitoring at BNTC utilize HVB as the on-site reference stream.

Results of the RBP for the two streams draining the Old Landfill (EBT and WBT) determined that degraded benthic macroinvertebrate communities exist in these two streams. In addition, physical habitat at WBT was severely degraded and incapable of supporting a healthy aquatic community. It should be noted that the RBP study has not investigated whether or not contaminants derived from BNTC activities are the causative factor responsible for the degraded benthic communities within these two streams. The RBP, however, did identify the presence of poor physical habitat which can be a major factor resulting in the degradation of the benthic community.

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INTRODUCTION

The Bainbridge Naval Training Center (BNTC) is located in the Susquehanna River watershed near the town of Port Deposit, Maryland. BNTC was an active Navy training facility from 1941 to 1949, 1951 to 1957, and 1972 to 1976 (Ecology and Environment 1997). Part of the facility was used as a Job Corps Center by the Department of Labor between 1978 and 1990. The site has been largely unused since 1990 and will be transferred to the State of Maryland in the near future.

Through the Department of Defense's Installation Restoration Program (IRP), the Navy identified two primary areas of environmental concern at BNTC--the Old Landfill and the Fire Training Area. Both sites were areas in which hazardous materials and regulated substances had been historically used or stored (Ecology and Environment 1997). The Old Landfill was used for disposal of pesticides, asbestos, and other contaminants from the early 1940s through 1976. The Fire Training Area contained several brick buildings, an oil separator pit, underground vaults and underground storage tanks. For both sites, risks to human health and the environment are being investigated according to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process. Sampling was conducted in 1991 and 1994 and Interim Remedial Actions were performed in 1994-95 to remove the sources of contamination.

In 1998, a desktop Ecological Risk Assessment (ERA) was completed for the BNTC by the U.S. Fish and Wildlife Services's Chesapeake Bay Field Office. CBFO results of the ERA suggested that benthos and fish are likely to be at risk in aquatic habitats near the Old Landfill. The ERA also determined that risks to benthos and fish appear to be unlikely in aquatic habitats draining the Fire Training Area (Pinkney and Johnson, 1998).

In addition to the potential risk from chemical contaminants, another threat to the benthic community in streams near the Old Landfill appears to be habitat degradation. Sandy soils from the landfill area have entered the West Branch Tributary (WBT) and continued downstream after the confluence of the East Branch Tributary (EBT). The Navy will complete a remedial action to eliminate this source in September, 1999.

One of the risk management recommendations that resulted from the ERA was an assessment of the ecological condition of three streams draining BNTC Areas of Concern using the EPA Rapid Bioassessment Protocol (RBP). The RBP involves the biological (fish and or/macroinvertebrate community) and physical (habitat) characterization of stream quality. This inexpensive screening tool can be used to: determine if a given stream is supporting or not supporting a designated aquatic life use; characterize the existence of and severity of use impairment; help to identify sources and causes of use impairment; evaluate the effectiveness of control actions and restoration activities; and support cumulative impact assessments (Plafkin *et al.* 1989, Barbour *et al.* 1997). In this study, results of the RBP will be used to determine the existing physical and biological condition of three streams at BNTC. These data can serve as a baseline to evaluate changes in stream quality following remediation of the Old Landfill as a source of sediment loading.

METHODS

Site Description

Three on-site BNTC streams and an off-site reference stream (within the Susquehanna River watershed) were selected for this study. A single 100 m reach was used as representative of the stream.

The East Branch Unnamed Tributary (EBT) is a shallow, first order stream draining the east side of the BNTC Old Landfill (Figure 1). Water depths at this site were generally less than one foot. The stream flows through a mixed deciduous forested area, with the banks of the stream heavily vegetated by herbaceous and shrub type species. Instream habitat contained a mix of small riffle areas, shallow pools and an abundance of woody debris and snags. EBT drains into the West Branch Unnamed Tributary, downstream of the study reach, near the Old Water Tower located next to Rt. 276.

West Branch Unnamed Tributary (WBT) is a shallow, first order stream draining the west side of the BNTC Old Landfill, flowing parallel to Rt. 276 (Figure 1). Water depths at this site were similar to EBT. Historically, runoff from the Old Landfill entered the stream; however, sediment loading into the stream has recently been minimized by stabilization of the Old Landfill banks. The portion of stream in the study reach (located primarily on state property) is channelized, with concrete replacing the natural bank for most of its length. This section of the stream was selected because the stream reach located on BNTC property was being worked on by the site engineers and construction crew during the time of sampling. The section of stream occurring on the BNTC is bounded by grasses, with no forested riparian area present. Once the stream exits the BNTC property (beginning of study reach), a marginal forested riparian area exists on the east bank of the stream. Instream habitat is uniform in nature, with few riffles and pools present. In addition, WBT receives highway runoff and its associated contaminants from Rt. 276 during precipitation events.

Happy Valley Branch (HVB) is a second order stream that drains the Fire Training Area (Figure 2). It is designated as a trout propagation stream by the Maryland Department of Natural Resources (MDNR). HVB flows through an extensive forested riparian area composed mostly of mixed deciduous tree species. In stream habitat is composed of riffles, pools, and an abundance of woody debris and snags.

Big Branch (BBR) is a second order stream located in Harford County, Maryland adjacent to MD Rt. 136 (approximately 5 miles west of Harkins) (Figure 3). BBR was identified by personnel from the Maryland Biological Stream Survey (MBSS) (S. Stranko, MDNR, personal communication) as a reference stream and was used for comparative purposes in this investigation. The stream flows through a forested riparian area, bordered by some agricultural land. The stream is characterized by a number of moderate to large riffles; shallow and deep pools; and abundant woody debris and snags. Reference conditions found at BBR were used to scale the assessment to the "best attainable" situation. The ratio between the score for the BNTC sites and the score for the reference condition provided a percent comparability measure for each

site. Each BNTC site was then classified on the basis of its similarity to expected conditions found at BBR, and its apparent potential to support an acceptable level of biological health (Barbour *et al.* 1997)

Field Methods

In December 1998, CBFO Environmental Contaminants personnel conducted water quality measurements and the RBP (physical habitat assessment and biological assessment) at the three BNTC streams and the reference stream. Water quality was measured at each site using a Hydrolab Surveyor 4 Data Sonde Unit (Hydrolab Inc., Austin, TX). Hydrolab units were calibrated before field use (same day as field sampling). Water temperature, pH, conductivity, dissolved oxygen (D.O.), percent oxygen saturation, turbidity, salinity, and depth were the parameters measured . In addition, general physical characteristics of the immediate area were also recorded (Figure 4a).

The RBP methods used in this ecological assessment are based on those developed by Plafkin *et al.* (1989). These methods were used to assess overall physical habitat and biological health within each stream. All physical habitat data collection and benthos sampling took place within a 100 m reach of stream.

Physical habitat data was based upon 10 in-stream variables that included: epifaunal substrate, pool substrate, pool variability, sediment deposition, channel flow, channel alteration, channel sinuosity, bank stability, vegetative protection, and riparian zone width. See Figure 4b for an example of the physical habitat assessment data sheet and a description of the physical habitat parameters.

Benthic macroinvertebrate community composition within each stream was based on twenty benthos samples collected from a proportion of four in-stream habitats that were present. In-stream habitats sampled were: substrate type (cobble, sand and other fine sediment), snags, vegetated banks, and submerged aquatic vegetation). A sample consisted of a single jab in a designated habitat type with two sweeps of a D-frame net (mesh size = 500 u) within a 1 meter area (Barbour *et al.* 1997). Invertebrate samples were placed in glass jars and preserved in 70% ethanol. Samples were sorted in the laboratory using the methods described by Barbour *et al.* (1997). All benthos were identified in the laboratory to the lowest possible taxa by a trained aquatic invertebrate taxonomist familiar with regional benthic fauna.

Bioassessments of each stream were based on a number of metrics that evaluate macroinvertebrate community composition within each stream. In addition, multimetric assessments provide detection capability over a broader range and nature of stressors and give a more complete picture of biological condition than single biological indicators (Barbour *et al.* 1995). The Ohio Environmental Protection Agency (1987) suggested that the combined strength of the metrics minimizes any individual weaknesses.

Data Analysis

Physical habitat data was assessed and evaluated using the percent comparability of the BNTC streams to the reference site (Figure 5). Use of a percent comparability evaluation allows for regional and stream-size differences which affect flow or velocity, substrate, and channel morphology (Plafkin *et al.* 1989). In an effort to make a valid assessment of the benthic communities and health of the streams, four benthic metrics, and three ecological indices were used to evaluate overall benthic health within each stream. Benthic metrics included: taxa richness; Ephemeroptera, Plecoptera, and Trichoptera (EPT) Index; percent dominant taxa; and Community Loss Index. The values obtained for each metric were given a score of 6, 3, or 0, based on percent comparability to the reference site (Figure 6).

The three ecological indices used were species diversity (Shannon's and Simpson's Diversity Indices); equitability (based on Simpson's Indices); and community similarity (Jaccard's Coefficient of Community) (Barton and Metcalfe-Smith, 1992; Camargo, 1993, Rosenburg and Resh, 1993). Values obtained for these indices are based on a score of 0.0 - 1.0, with the premise that as environmental stress increases, index values decrease. Formulae for the above indices can be found in Brower *et al.* (1990) and Plafkin *et al.* (1989).

RESULTS

Water Quality

Evaluation of the water quality data showed no abnormal values. Values obtained at each site were within the range expected to be found in freshwater streams in the region. D.O. and pH met the U.S. Environmental Protection Agency (USEPA) Ambient Water Quality Criteria for D.O. and pH in freshwater streams (USEPA, 1986,1998). It was noted, however, that WBT was the only stream without saturated D.O. levels, had the highest conductivity, and lowest pH values of the four streams (Table 1). Coincidentally WBT ranked the lowest in terms of the physical habitat assessment and benthic bioassessment (see Tables 2, 3, and 4). The water quality values observed at WBT, however, should not be considered to be having an adverse impact on aquatic biota. Although WBT had non-saturated D.O. levels, the values observed approximated 90 percent saturation and probably had minimal effect on in-stream fauna.

Physical Habitat

As expected, BBR had the highest physical habitat score, scoring 168 points out of a possible 200. HVB scored 163 points, while EBT and WBT had scores of 140 and 84 points respectively. HVB was considered comparable to the reference site, with a score of 97%. EBT and WBT were both rated as moderately impaired, scoring 83% and 52% respectively (Tables 2, 3, and 4).

Benthos - RBP Metrics

All benthic metrics results in this report are based on the family level. Damage incurred by some specimens made it impossible to identify to the genus or species level, especially members from the family Chironomidae (order Diptera) (Appendix B).

Taxa Richness: HVB and BBR had the greatest taxa richness, with 33 and 32 invertebrate families represented respectively. Taxa richness was reduced to 24 families at site EBT, followed by 21 families at WBT. When compared to the reference stream, HVB exceeded 100 percent due to the slightly higher number of taxa found at this stream. EBT and WBT had scores of 75% and 65% respectively. Final metric scores were 6, 3, and 3 for HVB, EBT and WBT respectively (Tables 2, 3, and 4)

EPT Index: EPT Index scores were the highest at BBR and HVB, EPT scores for these site were 19 and 16 respectively. EPT Index scores were reduced to 9 at EBT, and 3 at WBT. When compared to the reference site, HVB had a score of 84%, whereas EBT and WBT scored 47% and 16%, respectively. Final metric scores were 3, 3, and 0 for HVB, EBT and WBT respectively (Tables 2, 3, and 4)

Percent Dominant Taxa: The family Ephemerellidae (order Ephemeroptera) was the dominant taxa found at BBR and represented 32% of the taxa at this site. The family Chironomidae (order Diptera) was the dominant taxa found at the other three sites. Chironomids represented 34% and 33% of the taxa found at HVB and EBT, respectively. Chironomids represented 70% of the taxa found at WBT. BBR, HVB, and EBT each had metric scores of 3, whereas WBT scored 0 (Tables 3 and 4)

Community Loss Index values (based on reference taxa richness value) were 0.39 at HVB, increasing to 0.87 at EBT and 1.2 at WBT. HBV had a metric score of 6, whereas EBT and WBT each scored 3 (Tables 2 and 4)

The total score (as percent comparable to the reference site) of the bioassessment using the benthic metrics for each stream showed that HVB Branch was 86% comparable to the reference site, indicating that it was non-impaired. EBT was 43% comparable to the reference site, indicating that it was moderately impaired. WBT was also rated as moderately impaired with a score of 29% (Table 4).

Ecological Indices

Species Diversity Indices: Species diversity indices scores were high at all sites excluding WBT. Shannon's Diversity Index (H') scores for BBR, HVB, and EBT ranged from 0.94 - 0.98. Simpson's Diversity Index (Ds) scores were also relatively high at the same three sites, ranging from 0.83 - 0.84. H' and Ds scores for WBT were 0.55 and 0.49 respectively (Table 2).

Equitability Index: Equitability (E') scores, were similar at sites BBR, HVB and EBT, with values ranging from 0.85 - 0.87. Equitability was reduced at site WBT with E' scores of 0.52 (Table 2).

Similarity: Jaccard's Coefficient of Community (CCj), a measure of community similarity (as compared to the reference stream) was highest at HVB, with a score of 0.41. CCj was further reduced to 0.24 at site EBT, and to 0.15 at WBT (Table 2).

DISCUSSION

Of the three BNTC sites evaluated, HVB was rated as the least impacted, followed by EBT. WBT ranked as the most impacted. According to the criteria characterization of biological condition for RBP II (Figure 6), HVB is comparable to the best situation to be expected within the ecoregion. A balanced trophic structure exists, as does optimum community structure for the given stream size and habitat quality. Because HVB is highly comparable to the reference stream in terms of physical habitat and biological condition, HVB could have been utilized as the reference site for this investigation. The overall RBP scores reaffirms the 1998 ERA results conducted earlier by the USFWS which stated that risks to benthos and fish from contaminants derived from the Fire Training Area appear unlikely. Water quality results, similar ecological indices values (Tables 1 and 2), and the presence of stone flies from the family Chloroperlidae (order Plecoptera), an extremely pollution sensitive group at only the reference site and HVB (Appendix B), provides further support for this assessment and evaluation of HVB.

It was also interesting to note the possible existence of the subterranean amphipod, *Stygobromus tenuis tenuis* or *S. tenuis potamacus*, at HBV and EBT. This species is listed by the Maryland Natural Heritage Program as possibly rare or uncommon in Maryland (MDNR, 1994). The presence of these organisms indicates that specialized habitats exist, and that these sites may need to be protected from further degradation. The specimens will be sent to Dr. John Holsinger (Old Dominion University, Richmond, VA), a specialist in *Stygobromus* identification, for verification.

RBP scores for EBT and WBT indicated that both of these sites were moderately impaired with respect to biological conditions. Based on the criteria characterization of biological condition for RBP II (Figure 6), EBT and WBT are moderately impaired because a number of intolerant forms have been lost as indicated by a reduction in the EPT Index. EPT Index values for these two sites were below 50 percent of the reference value, ranging from 47 to 16 percent (Table 3).

Based on the EBT and WBT physical habitat scores, only EBT is capable of supporting an acceptable level of aquatic biological health. A major physical habitat limiting factor at EBT was its reduced pool variability score (Appendix A). The pools found at this site were few, and shallow, thereby reducing in-stream habitat. Streams with monotonous pool characteristics frequently do not have sufficient habitat to support a diverse aquatic community, although species diversity indices calculated at EBT appear to contradict this theory (Table 2). An explanation for high species diversity observed at this site may be attributed to the extensive amount of woody

debris present in the stream (Allan 1995). In-stream woody debris provides epifaunal substrate for benthos to colonize. Benke *et al.* (1984) showed that woody debris and snags support greater number of taxa than does sand or mud. The irregularity of woody surface areas and effects of physical flow of the water, are important attributes of woody debris that contribute to habitat variability (Allan 1995). A score in the sub-optimal category of the pool variability habitat parameter would have made EBT comparable to the reference site in terms of habitat quality.

Physical habitat conditions at WBT are likely to contribute to a low level of biological health. Six physical habitat parameters at WBT had scores in the poor condition category. Those physical habitat parameters with poor condition categories were: epifaunal substrate and available cover for macroinvertebrates; pool variability; channel alteration; channel sinuosity; vegetative bank protection; and width of vegetative riparian zone (Appendix A). A major influencing factor for the low scores in the above habitat parameters can be attributed to the stabilization of the stream bank with concrete. These physical habitat parameters are essential in providing diverse habitats for aquatic biota, their limited presence is a primary reason why this particular site consistently scored the lowest in all physical habitat scores, bioassessment metrics, and ecological indices.

The elevated dominance of the dipteran family Chironomidae (70% of the taxa present) also suggests in-stream disturbances are present at this site. Chironomid percentages at WBT (70%) approach 75 %, a value associated with metal contamination, whereas unpolluted sites should have chironomid percentages less than 20% (Barton and Metcalfe-Smith, 1992). It should be noted that chironomid percentage at BBR was 11%. Plafkin *et al.* (1989) and Rosenburg and Resh (1993) also associate high chironomid percentages with metal contamination. The abundance of iron particulates within the stream appears to substantiate this observation.

During the physical characterization of the site it was noticed that an abundance of iron precipitate was present in the stream, indicating that dissolved oxygen was being utilized to oxidize dissolved iron (ferrous iron) to its reduced form as ferric iron, and precipitating out as iron particulates in the form of ferric oxide and ferric hydroxide (Appendix A). This oxidation-reduction process, could be a major factor responsible for the low D.O. levels found at this site (Reid 1961; Dunne and Leopold 1978). The presence of iron precipitates may also contribute to the lowered bioassessment of this site. Dunne and Leopold (1978) state that iron precipitates are very damaging to aquatic life, smothering respiratory organs, eggs, and food sources.

In addition to the presence of degraded habitat conditions and landfill runoff (it should be noted that sand is no longer running off the Old Landfill), further in-stream stresses are likely placed on WBT from MD Route 276. WBT is in close proximity to MD Route 276, which has no road-side riparian area (Figure 1, Appendix A). Therefore, it receives a large amount of highway surface runoff and associated contaminants during precipitation events. These additional stream inputs are also most likely impacting aquatic biota in this stream.

In summary, the findings of this investigation concur with the findings of the BNTC ERA conducted in 1998. Based on RBP methods, degraded benthic macroinvertebrate communities were found in two streams (EBT and WBT) draining the Old Landfill. The 1998 ERA concluded that risks from contaminants derived from the Old Landfill to benthos and fish were likely in

aquatic habitats streams draining the Old Landfill. It should be noted that the RBP study has not investigated whether or not contaminants derived from BNTC activities are the causative factor responsible for the degraded benthic communities within these two streams. The RBP has, however, identified the presence of poor physical habitat which can be a major factor resulting in the degradation of the benthic community.

The bioassessment and physical habitat assessment results for the stream (HVB) draining Fire Fighting Area of this investigation also supported the findings of the ERA, that risks from contaminants derived from the Fire Fighting Area to benthos and fish are unlikely. In fact, the overall RBP scores for this stream were so high that HVB could have been used as a reference stream for this investigation. It is recommended that future aquatic biomonitoring at BNTC utilize HVB as the on-site reference stream.

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Figure 1. Location of East Branch and West Branch Tributaries (EBT and WBT) located adjacent to the Bainbridge Naval Training Center Old Landfill (From Ecology and Environment, Inc. 1997).

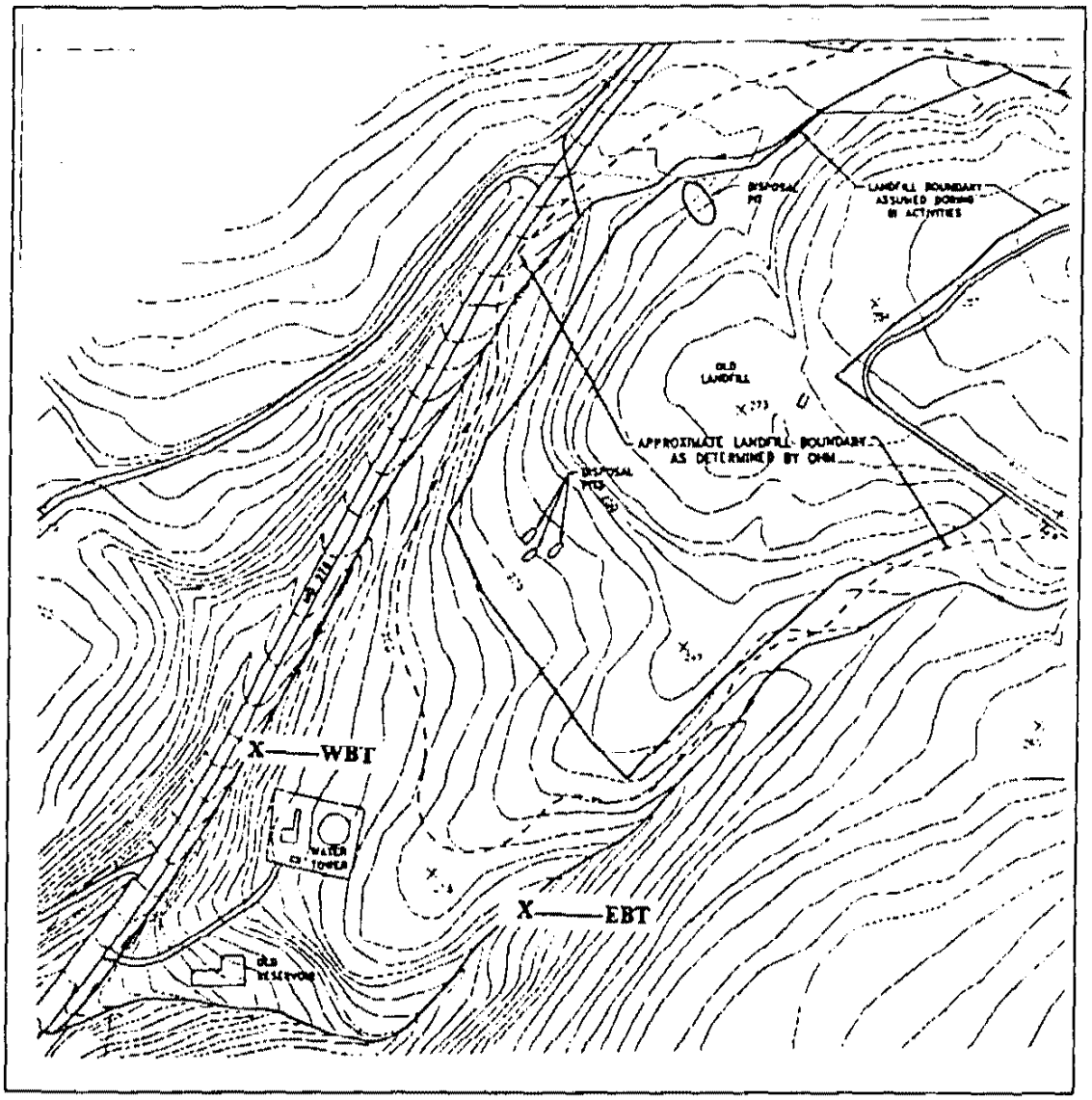


Figure 2. Location of Happy Valley Branch (HVB) located adjacent to the Bainbridge Naval Training Center RBP Fire Training Area (From Ecology and Environment Inc. 1997).

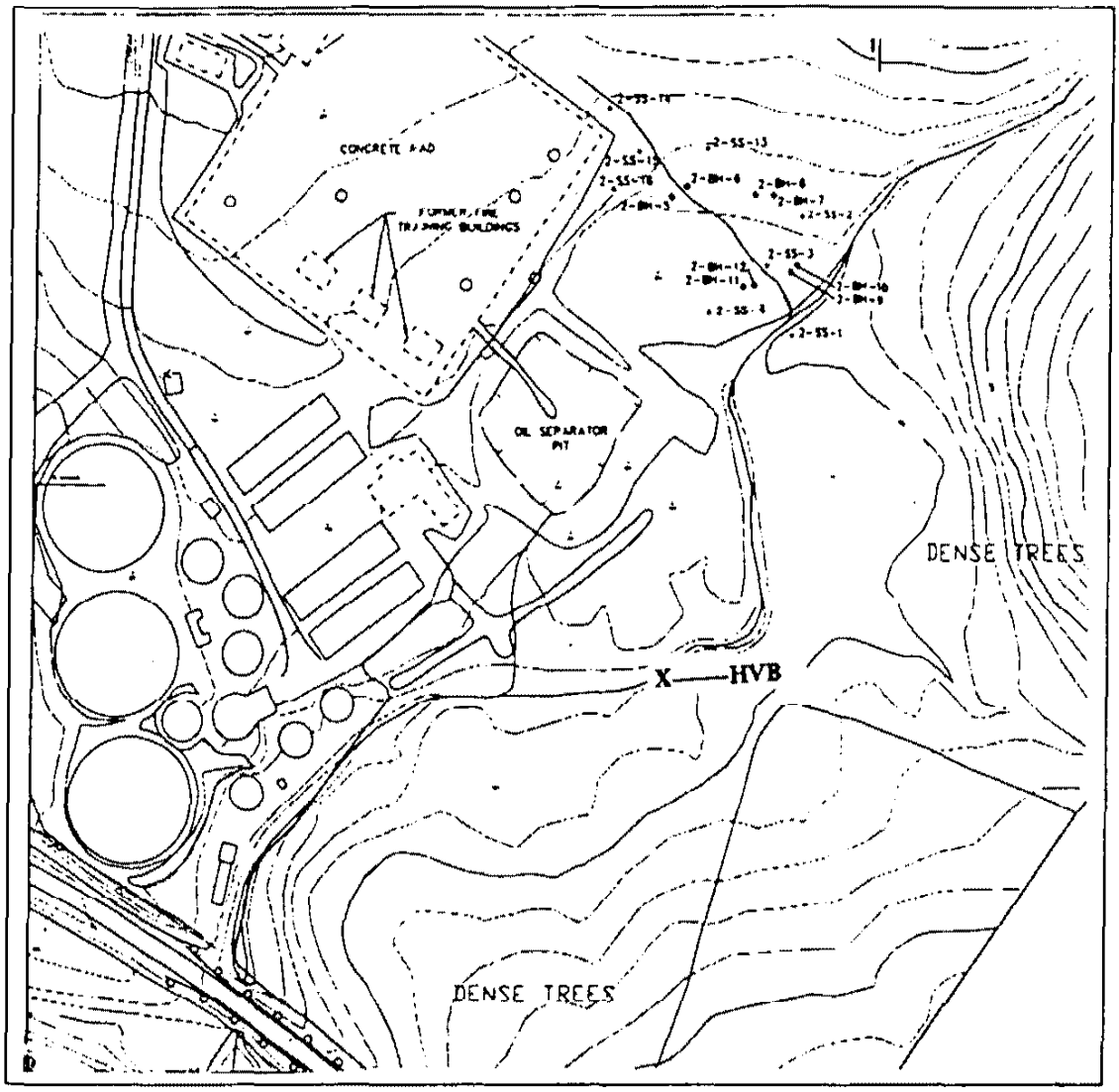


Figure 3. Location of the reference stream, Big Branch (BBR), that was used for the Bainbridge Naval Training Center RBP assessment. Stream is located in Harford County, Maryland, adjacent to Md. Rt. 136 (USGS 7.5" Quad - MD-Fawn Grove).

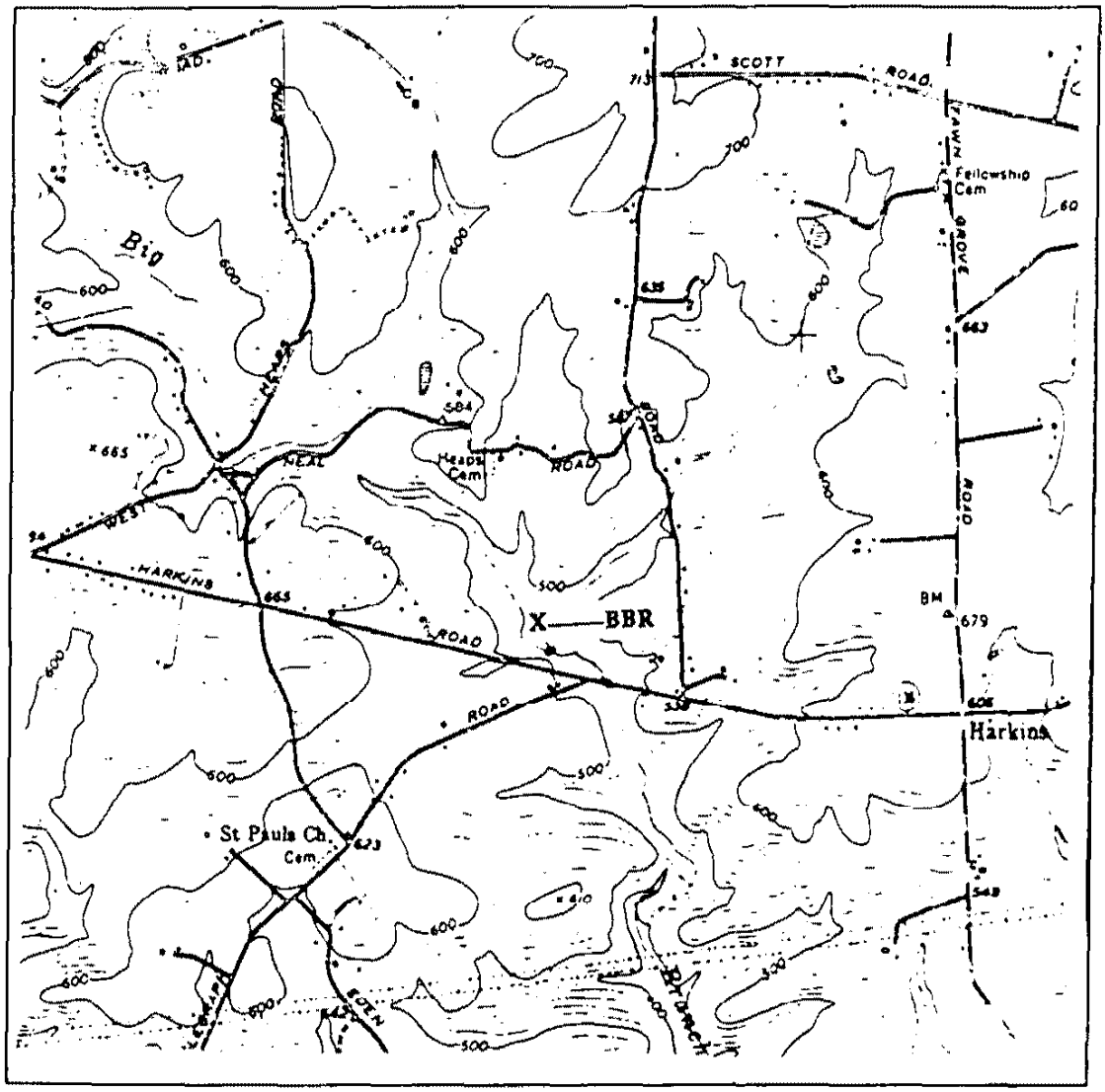


Figure 4a. Physical Characterization/water Quality Field Data Sheet (Front) (From Barbour *et al.* 1997)

STREAM NAME :	LOCATION:	
STATION #_____ RIVERMILE_____	STREAM CLASS:	
LAT _ LONG _____	RIVER BASIN:	
STORET #	AGENCY: U.S. Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS:		
FORM COMPLETED BY:	DATE _____ TIME _____ AM PM	REASON FOR SURVEY:

WEATHER CONDITIONS	Now ❑ ❑ ❑ ❑ ____% ❑	Past 24 hours ❑ storm (heavy rain) ❑ rain (steady rain) ❑ showers (intermittent) ❑ ____% cloud cover ❑ clear/sunny	Has there been a heavy rain in the last 7 days? ❑ Yes ❑ No Air Temperature____°C Other_____
SITE LOCATION/MAP	Draw a map of the site and indicate the areas sampled (or attach a photgraph)		
STREAM CHARACTERIZATION	Stream Subsystem ❑ Perennial ❑ Intermittent ❑ Tidal Stream Origin ❑ Glacial ❑ Spring-fed ❑ Non-glacial montane ❑ Mixture of origins ❑ Swamp and bog ❑ Other_____		Stream Type ❑ Coldwater ❑ Warmwater Catchment Area_____km²

Figure 4a. Cont'd. Physical Characterization/water Quality Field Data Sheet (Back) (From Barbour *et al.* 1997)

WATERSHED FEATURES

Predominant Surrounding Landuse
☐ Forest ☐ Commercial
☐ Field/Pasture ☐ Industrial
☐ Agricultural ☐ Other _____
☐ Residential

Local Watershed NPS Pollution
☐ No evidence ☐ Some potential sources
☐ Obvious sources

Local Watershed Erosion
☐ None ☐ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous

dominant species present _____

INSTREAM FEATURES

Estimated Stream Width _____m
Estimated Stream Depth _____m
Surface Velocity _____m/sec (at thalweg)
Estimated Reach Length _____m
Canopy Cover
☐ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark _____m
Proportion of Reach Represented by Stream Morphology Types
☐ Riffle _____% ☐ Run _____%
☐ Pool _____%
Channelized ☐ Yes ☐ No
Dam Present ☐ Yes ☐ No

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free Floating
☐ Floating Algae ☐ Attached Algae

dominant species present _____

Portion of the reach with aquatic vegetation _____%

WATER QUALITY

Temperature _____°C
Depth _____ m
Specific Conductance _____ mS
Salinity _____
Oxidation Reduction Potential: _____ mV
Dissolved Oxygen _____ mg\L
Percent Saturation _____
pH _____
Turbidity _____ NTU
Battery _____ V
WQ Instrument: Used Hydrolab Data Sonde 4

Water Odors
☐ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other _____

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☐ None ☐ Other _____

Turbidity (if not measured)
☐ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other _____

SEDIMENT/ SUBSTRATE

Odors
☐ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other _____

Oils
☐ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand
☐ Relict shells ☐ Other _____

Looking at stones which are not deeply embedded, are the undersides black in color?
☐ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock			Detritus	sticks, wood, coarse plant materials (CPOM)	
Boulder	> 256 mm (10")				
Cobble	64-256 mm (2.5"-10")		Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")				
Sand	0.06-2mm (gritty)		Marl	grey, shell fragments	
Silt	0.004-0.06 mm				
Clay	< 0.004 mm (slick)				

Figure 4b. Habitat Assessment Field Data - Low Gradient Streams Sheet (Front) (From Barbour *et al.* 1997)

STREAM NAME:	LOCATION:	
STATION #_____ RIVERMILE_____	STREAM CLASS:	
LAT _____ LONG _____	RIVER BASIN:	
STORET #	AGENCY: U.S. Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS:		
FORM COMPLETED BY:	DATE _____ TIME _____ AM PM	REASON FOR SURVEY:

	Habitat Parameter	Condition Category			
		Optimal	Suboptimal	Marginal	Poor
Pa	1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
	5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Figure 4b. Cont'd. Habitat Assessment Field Data - Low Gradient Streams Sheet (back) (From Barbour *et al.* 1997)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score _____

Figure 5. RBP scoring criteria used to evaluate physical habitats of streams that have been compared to reference conditions (From Plafkin *et al.* 1989).

Assessment Category	Percent of Comparability
Comparable to reference	$\geq$ 90%
Supporting	75-88%
Partially Supporting	60-73%
Non-Supporting	$\leq$ 58%

Figure 6. Flow chart of bioassessment approach advocated for Rapid Bioassessment Protocol II (From Plafkin, 1989).

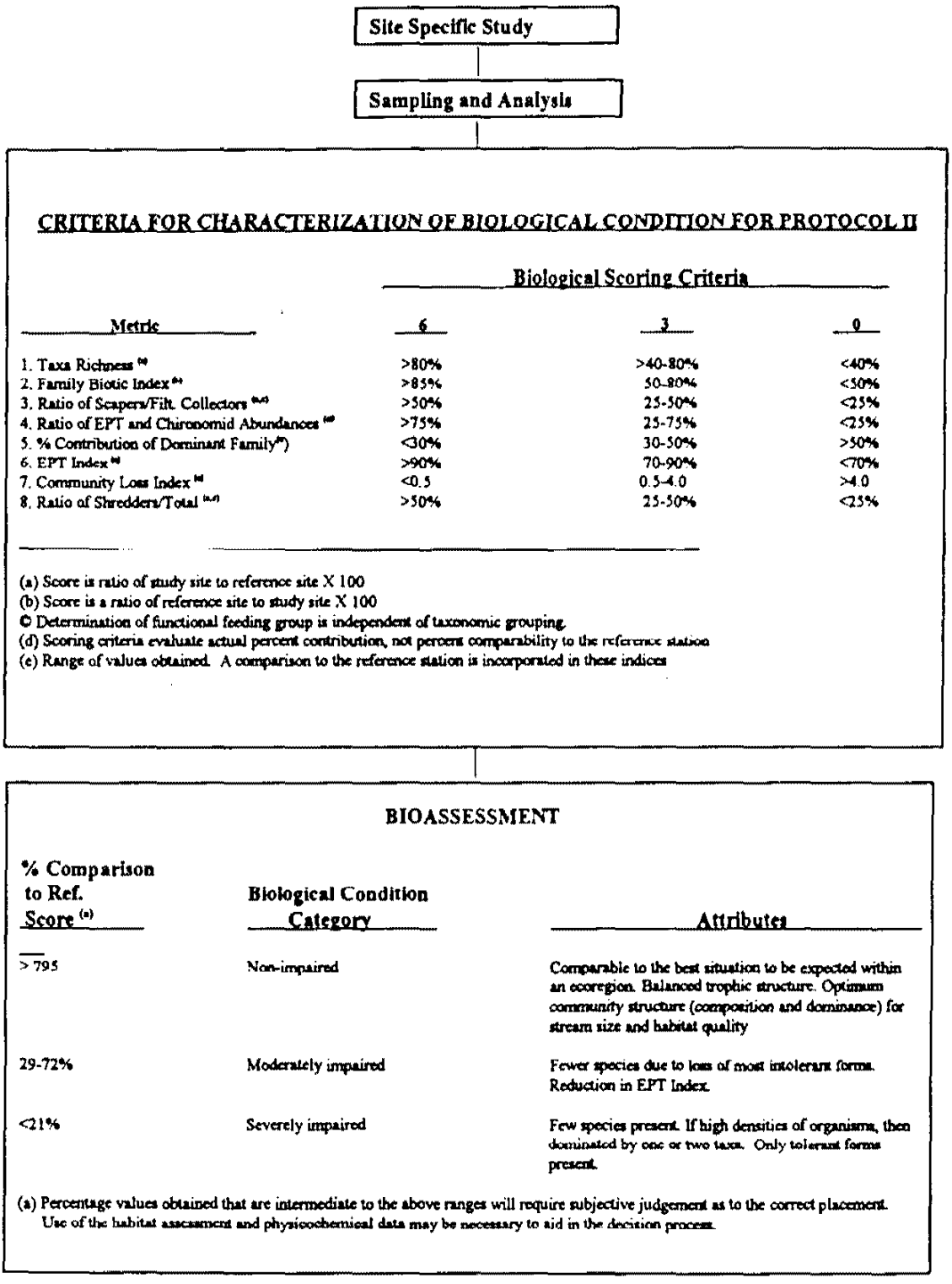


Table 1. Water quality data collected in December, 1998 while conducting Rapid Bioassessment Protocol at sites (HVB, EBUT, and WBT) located at Bainbridge Naval Training Center, Cecil County Maryland, and a reference site (BBR) located in Harford County Maryland.

Site	Temperature (°C)	pH	Conductivity (ms)	D.O (ppm)	% Saturation	Turbidity (NTU)	Salinity (‰)	Depth (m)
[1]HVB	7.1	7.65	0.202	12.89	104.5	N/A	0.09	0.2
[2]EBT	6.86	7.57	0.334	13.62	111.4	0	0.16	0.02
[3]WBT	6.28	7.40	0.635	11.11	88.6	18.7	0.33	0.11
[4]BBR	9.3	7.52	0.103	12.5	109.2	14.7	0.04	0.9

1 HVB - Happy Valley Branch
2 EBT - East Branch Unnamed Tributary
3 WBT - West BranchUnnamed Tributary
4 BBR - Big Branch, Reference site

Table 2. Physical habitat, bioassessment metrics, and ecological indices values for Bainbridge Naval Training Center streams and reference stream used for RBP assessment.

RBP Metric / Ecological Index	SITE			
	BBR[1]	HVB[2]	EBT[3]	WBT[4]
Physical Habitat (max score = 200)	168	163	140	84
# Individuals	2255	1879	324	411
# Orders	10	11	11	9
# Families (taxa richness)	32	33	24	21
EPT Index (total EPT taxa)	19	16	9	3
Community Loss Index		0.39	0.87	1.20
% Dominant Taxa (Family)	32.2 (Ephemerellidae)	34.4 (Chironomidae)	32.7 (Chironomidae)	69.8 (Chironomidae)
H' (Shannon's Index)	0.94	0.96	0.98	0.55
Ds (Simpson's Index)	0.83	0.82	0.84	0.49
E' (Equitability - based on Simpson's Index)	0.85	0.85	0.87	0.52
Community Similarity (Jaccard Coefficient)		0.41	0.24	0.15

1 BBR - Big Branch, Reference site
2 HVB - Happy Valley Branch
3 EBUT - East Branch Unnamed Tributary
4 WBT - West BranchUnnamed Tributary

Table 3. Percent comparison (to reference site - BBR) values of physical habitat and bioassessment metrics for Bainbridge Naval Training Center streams (HVB, EBT, and WBT).

Metric	SITE			
	BBR[1]	HVB[2]	EBT[3]	WBT[4]
Physical Habitat (based on score of 168 points- 200 points possible)	100	0.97	0.83	0.52
# Families (taxa richness)	100	103	75	65
EPT Index	100	84	47	16
Community Loss Index	-	-	-	-
% Dominant Taxa (Family)	32.0 (Ephemerellidae)	34.0 (Chironomidae)	33.0 (Chironomidae)	70.0 (Chironomidae)

1BBR - Big Branch, Reference site
2 HVB - Happy Valley Branch
3 EBUT - East Branch Unnamed Tributary
4 WBT - West BranchUnnamed Tributary

Table 4. Overall RBP physical habitat and bioassessment scores, and evaluations based on percent comparison to reference site values (see Figure 6 for scoring criteria).

RBP METRIC	SITE			
	BBR[1]	HVB[2]	EBT[3]	WBT[4]
Physical Habitat Assessment evaluation		Comparable	Supporting	Non-supporting
# Families (taxa richness)	6	6	3	3
Total EPT	6	3	0	0
Community Loss Index	6	6	3	3
% Dominant Taxa	3	3	3	0
Total Score	21	18	9	6
Percent Comparability to Reference Site	100	86	43	29
Bioassessment evaluation	Non-impaired	Non-impaired	Moderately impaired	Moderately impaired

1 BBR - Big Branch, Reference site
2 HVB - Happy Valley Branch
3 EBT - East Branch Unnamed Tributary
4 WBT - West BranchUnnamed Tributary

Appendix A

Rapid Bioassessment Protocol Data Forms

(Physical Characterization/Water Quality, and Habitat Assessment Field Data Sheets)

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

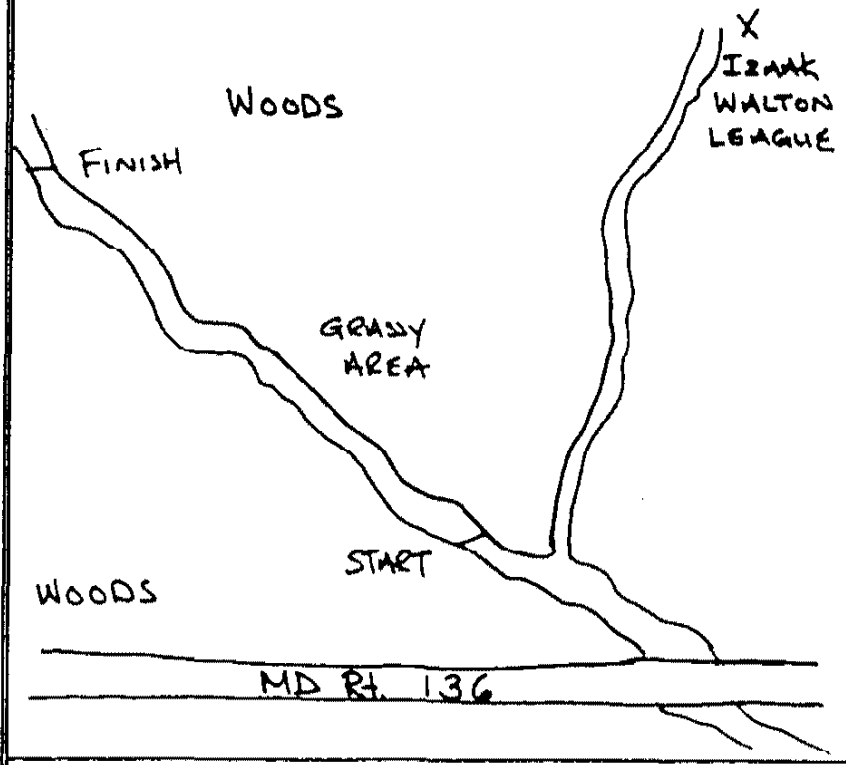
STREAM NAME : Big Branch - reference (BBR)	LOCATION: Harkins, Harford County, MD near MD Rt. 136 crossing	
STATION #_____ RIVERMILE_____	STREAM CLASS: Second order	
LAT 39°41'.929 LONG 76° 28'.059	RIVER BASIN: Susquhanna River	
STORET #	AGENCY: U.S. Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan		
FORM COMPLETED BY: Dan Murphy	DATE 12/22/98 TIME 10:00 (AM) PM	REASON FOR SURVEY: Ecological Risk Assessment followup investigation

WEATHER CONDITIONS

Now	Past 24 hours	Has there been a heavy rain in the last 7 days?
☐	☐ storm (heavy rain)	☐ Yes ☐ No
☐	☐ rain (steady rain)	Air Temperature 12 °C
☐	☑ showers (intermittent)	Other_____
☑ 100 %	☐ ____%cloud cover	
☐	☐ clear/sunny	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☑ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☑ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial ☑ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other_____

Catchment Area_____ km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
☑ Forest ☐ Commercial
☑ Field/Pasture ☐ Industrial
☑ Agricultural ☐ Other _____
☐ Residential

Local Watershed NPS Pollution
☐ No evidence ☐ Some potential sources
☑ Obvious sources

Local Watershed Erosion
☐ None ☐ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☑ Trees ☑ Shrubs ☑ Grasses ☑ Herbaceous

dominant species present Black oak, BLACK CHERRY, RED MAPLE

INSTREAM FEATURES

Estimated Stream Width 5.0 m
Estimated Stream Depth 0.3 m
Surface Velocity (at thalweg) _____ m/sec
Estimated Reach Length 100 m
Canopy Cover
☑ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark _____ m
Proportion of Reach Represented by Stream Morphology Types
☐ Riffle 60 % ☐ Run 30 %
☐ Pool 10 %
Channelized ☐ Yes ☑ No
Dam Present ☐ Yes ☑ No

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free Floating
☐ Floating Algae ☐ Attached Algae

dominant species present _____

Portion of the reach with aquatic vegetation 0 %

WATER QUALITY

Temperature 9.3 °C
Depth 0.9 m
Specific Conductance 0.103 mS
Salinity 0.04
Oxidation Reduction Potential: 434 mV
Dissolved Oxygen 12.5 mg/L
Percent Saturation 109.2
pH 7.52
Turbidity 14.7 NTU
Battery 6.7 V
WQ Instrument: Used Hydrolab Data Sonde 4

Water Odors
☑ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other _____

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☑ None ☐ Other _____

Turbidity (if not measured)
☑ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other _____

SEDIMENT/ SUBSTRATE

Odors
☑ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other _____

Oils
☑ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☐ Sand
☐ Relict shells ☑ Other horse droppings

Looking at stones which are not deeply embedded, are the undersides black in color?
☑ Yes ☐ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		0	Detritus	sticks, wood, coarse plant materials (CPOM)	NA
Boulder	> 256 mm (10")	5			
Cobble	64-256 mm (2.5"-10")	30	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	30			
Sand	0.06-2mm (gritty)	30	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	5			
Clay	< 0.004 mm (slick)	0			

HABITAT ASSESSMENT FIELD DATA - LOW GRADIENT STREAMS SHEET (FRONT)

STREAM NAME: Big Branch - reference (BBR)	LOCATION: Harkins, Harford County, MD. Near MD Rt. 136 crossing	
STATION #_____ RIVERMILE_____	STREAM CLASS: Second order	
LAT 39°41'.929 LONG 76° 28'.039	RIVER BASIN: Susquehanna River	
STORET #	AGENCY: U.S Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan		
FORM COMPLETED BY: Dan Murphy	DATE 12/22/98 TIME 10 AM (AM) PM	REASON FOR SURVEY: Ecological Risk Assessment followup investigation

Pa

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover 18	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization no mats of vegetation	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 (7) 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 8 (LB)	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 6 (RB)	Right Bank 10 9	8 7 (6)	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0

Total Score 168

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

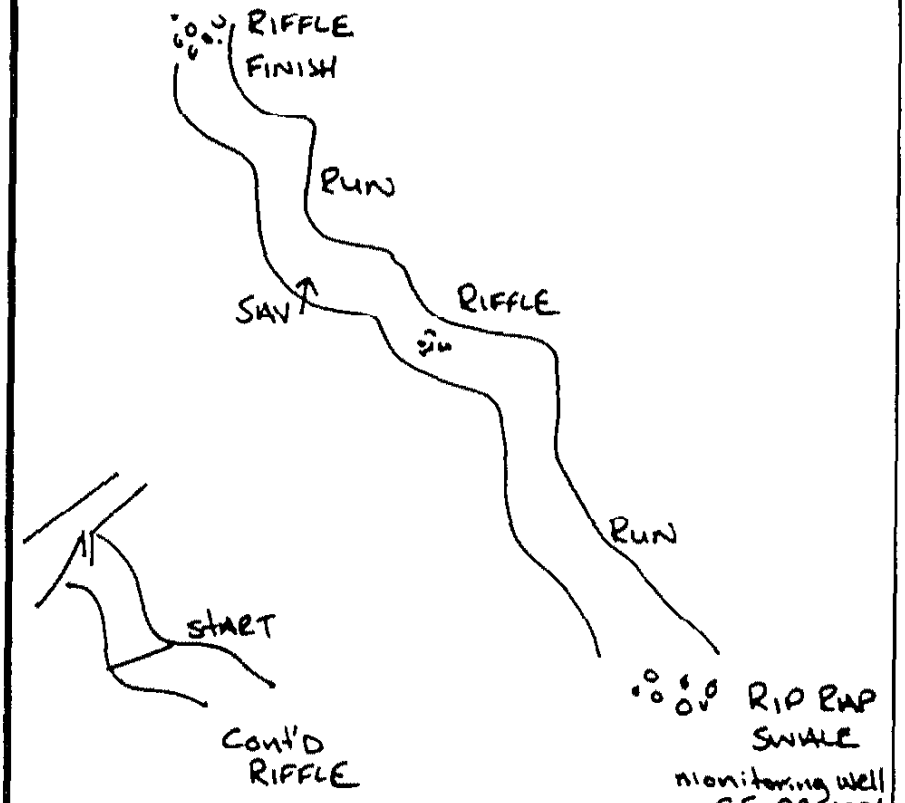
STREAM NAME : Happy Valley Branch (HBV)	LOCATION: Bainbridge Fire Training Area	
STATION #_____ RIVERMILE_____	STREAM CLASS: Second order	
LAT _____ LONG _____	RIVER BASIN: Susquhanna River	
STORET #	AGENCY: U.S. Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan		
FORM COMPLETED BY: Dan Murphy	DATE 12/11/98 TIME 2:00 (AM) (PM)	REASON FOR SURVEY: Ecological Risk Assessment followup investigation

WEATHER CONDITIONS

Now	Past 24 hours	Has there been a heavy rain in the last 7 days?
☐	☐ storm (heavy rain)	☒ Yes ☐ No
☐	☐ rain (steady rain)	Air Temperature 15 °C
☐	☐ showers (intermittent)	Other _____
☒ 10 %	☒ 15 %cloud cover	
☐	☐ clear/sunny	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☒ Coldwater ☐ Warmwater

Stream Origin
☐ Glacial
☐ Non-glacial montane
☐ Swamp and bog
☑ Spring-fed
☐ Mixture of origins
☐ Other ____?____

Catchment Area _____ km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
☑ Forest ☐ Commercial
☑ Field/Pasture ☐ Industrial
☐ Agricultural ☐ Other _____
☐ Residential

Local Watershed NPS Pollution
☑ No evidence ☐ Some potential sources
☐ Obvious sources

Local Watershed Erosion
☑ None ☐ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☑ Trees ☑ Shrubs ☐ Grasses ☐ Herbaceous

dominant species present _____

INSTREAM FEATURES

Estimated Stream Width 3.0 m
Estimated Stream Depth 0.2 m
Surface Velocity _____ m/sec (at thalweg)
Estimated Reach Length 100 m
Canopy Cover
☑ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark _____ m
Proportion of Reach Represented by Stream Morphology Types
☐ Riffle _____ % ☐ Run _____ %
☐ Pool _____ %
Channelized ☐ Yes ☑ No
Dam Present ☐ Yes ☐ No

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☑ Rooted floating ☐ Free Floating
☐ Floating Algae ☐ Attached Algae

dominant species present _____

Portion of the reach with aquatic vegetation 1 %

WATER QUALITY

Temperature 7.10 °C
Depth 0.2 m
Specific Conductance 0.202 mS
Salinity 0.09
Oxidation Reduction Potential: 278 mV
Dissolved Oxygen 12.89 mg/L
Percent Saturation 104.5
pH 7.65
Turbidity 81.0 NTU
Battery 6.9 V
WQ Instrument: Used Hydrolab Data Sonde 4

Water Odors
☑ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other _____

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☑ None ☐ Other _____

Turbidity (if not measured)
☑ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other _____

SEDIMENT/ SUBSTRATE

Odors
☑ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other _____

Oils
☑ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☑ Sand
☐ Relict shells ☐ Other _____

Looking at stones which are not deeply embedded, are the undersides black in color?
☐ Yes ☑ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		0	Detritus	sticks, wood, coarse plant materials (CPOM)	100
Boulder	> 256 mm (10")	1			
Cobble	64-256 mm (2.5"-10")	50	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	29			
Sand	0.06-2mm (gritty)	15	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	5			
Clay	< 0.004 mm (slick)	0			

HABITAT ASSESSMENT FIELD DATA - LOW GRADIENT STREAMS SHEET (FRONT)

STREAM NAME: Happy Valley Branch (HBV)	LOCATION: Bainbridge Fire Training Area	
STATION #_____ RIVERMILE_____	STREAM CLASS: Second order	
LAT _____ LONG _____	RIVER BASIN: Susquehanna River	
STORET #	AGENCY: U.S Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan		
FORM COMPLETED BY: Dan Murphy	DATE 12/11/98 TIME 2 100 AM (PM)	REASON FOR SURVEY: Ecological Risk Assessment followup investigation

Fu

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 18	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 (9) 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 17	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 14	20 19 18 17 16	15 (14) 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 6 (LB)	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 10 (LB)	Left Bank (10)	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10)	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE 9 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0

Total Score 163

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

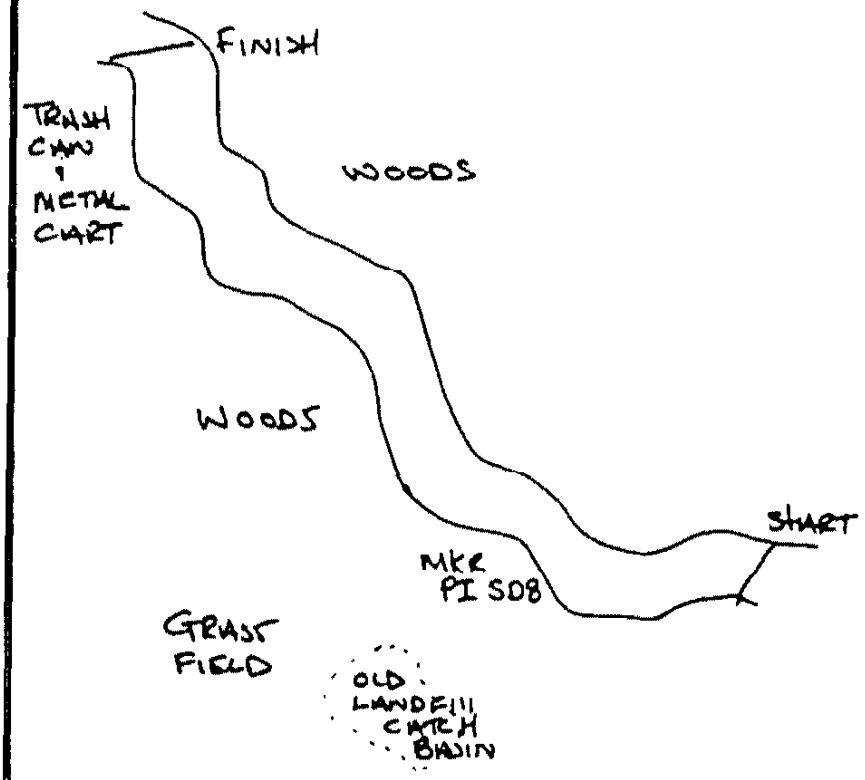
STREAM NAME : East Branch Tributary (EBT)	LOCATION: Bainbridge Old Landfill	
STATION #_____ RIVERMILE_____	STREAM CLASS: First order	
LAT_ LONG _____	RIVER BASIN: Susquhanna River	
STORET #	AGENCY: U.S. Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan		
FORM COMPLETED BY: Dan Murphy	DATE 12/11/98 TIME 11:30 (AM) PM	REASON FOR SURVEY: Ecological Risk Assessment followup investigation

WEATHER CONDITIONS

Now	Past 24 hours	Has there been a heavy rain in the last 7 days?
☐	☐ storm (heavy rain)	☐ Yes ☐ No
☐	☐ rain (steady rain)	Air Temperature 10 °C
☐	☐ showers (intermittent)	Other _____
☒ 15 %	☐ ___ %cloud cover	
☐	☐ clear/sunny	

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
☒ Perennial ☐ Intermittent ☐ Tidal

Stream Type
☐ Coldwater ☑ Warmwater ?

Stream Origin
☐ Glacial ☐ Spring-fed
☐ Non-glacial montane ☐ Mixture of origins
☐ Swamp and bog ☐ Other _____

Catchment Area _____ km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
☑ Forest ☐ Commercial
☑ Field/Pasture ☐ Industrial
☐ Agricultural ☑ Other OLD LANDFILL
☐ Residential ON RT SIDE FACING DOWNSTREAM

Local Watershed NPS Pollution
☑ No evidence ☐ Some potential sources
☐ Obvious sources

Local Watershed Erosion
☐ None ☑ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☑ Trees ☑ Shrubs ☐ Grasses ☐ Herbaceous

dominant species present 50% EACH; TULIP POPLAR, RED MAPLE, BLACK OAK

INSTREAM FEATURES

Estimated Stream Width 1.5 m
Estimated Stream Depth 0.02 m
Surface Velocity _____ m/sec (at thalweg)
Estimated Reach Length 100 m
Canopy Cover
☑ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark _____ m
Proportion of Reach Represented by Stream Morphology Types
☐ Riffle 70 % ☐ Run 30 %
☐ Pool _____ %
Channelized ☐ Yes ☑ No
Dam Present ☐ Yes ☑ No

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free Floating
☐ Floating Algae ☐ Attached Algae

dominant species present NONE; SOME MOSS PRESENT

Portion of the reach with aquatic vegetation 0 %

WATER QUALITY

Temperature 6.86 °C
Depth 0.02 m
Specific Conductance 0.534 mS
Salinity 0.16
Oxidation Reduction Potential: 384 mV
Dissolved Oxygen 13.62 mg/L
Percent Saturation 111.4
pH 7.57
Turbidity 0 NTU
Battery N/A V
WQ Instrument: Used Hydrolab Data Sonde 4

Water Odors
☑ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other _____

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☑ None ☐ Other _____

Turbidity (if not measured)
☑ Clear ☐ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other _____

SEDIMENT/ SUBSTRATE

Odors
☑ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☑ None
☐ Other _____

Oils
☑ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☑ Sand
☐ Relict shells ☐ Other _____

Looking at stones which are not deeply embedded, are the undersides black in color?
☐ Yes ☑ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		0	Detritus	sticks, wood, coarse plant materials (CPOM)	100
Boulder	> 256 mm (10")	10			
Cobble	64-256 mm (2.5"-10")	50	Muck-Mud	black, very fine organic (FPOM)	
Gravel	2-64 mm (0.1"-2.5")	20			
Sand	0.06-2mm (gritty)	20	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	0			
Clay	< 0.004 mm (slick)	0			

HABITAT ASSESSMENT FIELD DATA - LOW GRADIENT STREAMS SHEET (FRONT)

STREAM NAME: East Branch Tributary (EBT)	LOCATION: BainbridgeOld Landfill	
STATION # _____ RIVERMILE _____	STREAM CLASS: First order	
LAT _____ LONG _____	RIVER BASIN: Susquehanna River	
STORET #	AGENCY: U.S Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan		
FORM COMPLETED BY: Dan Murphy	DATE 12/11/98 TIME 11:30 (AM) PM	REASON FOR SURVEY: Ecological Risk Assessment followup investigation

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Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization No vegetation present 11	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE 11	20 19 18 17 16	15 14 13 12 (11)	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 (3) 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 16	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 10	20 19 18 17 16	15 14 13 12 11	(10) 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 19	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 12	20 19 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 6 (LB)	Left Bank 10 9	8 7 (6)	5 4 3	2 1 0
SCORE 8 (RB)	Right Bank 10 9	(8) 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 10 (LB)	Left Bank (10)	8 7 6	5 4 3	2 1 0
SCORE 10 (RB)	Right Bank (10)	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 10 (LB)	Left Bank (10) 9	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0

Total Score 140

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (FRONT)

STREAM NAME : West Branch Tributary (WBT)	LOCATION: Bainbridge Old Landfill. Along MD Rt. 276
STATION # _____ RIVERMILE _____	STREAM CLASS: First order
LAT _____ LONG _____	RIVER BASIN: Susquhanna River
STORET #	AGENCY: U.S. Fish and Wildlife Service - Chesapeake Bay Field Office
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan	
FORM COMPLETED BY: Dan Murphy	DATE 12/11/98 TIME 10:00 AM PM — REASON FOR SURVEY: Ecological Risk Assessment followup investigation

WEATHER CONDITIONS

Now
- ☐
- ☐
- ☐
- ☒ 75 %
- ☐

Past 24 hours
- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- ☒ 75 %cloud cover
- ☐ clear/sunny

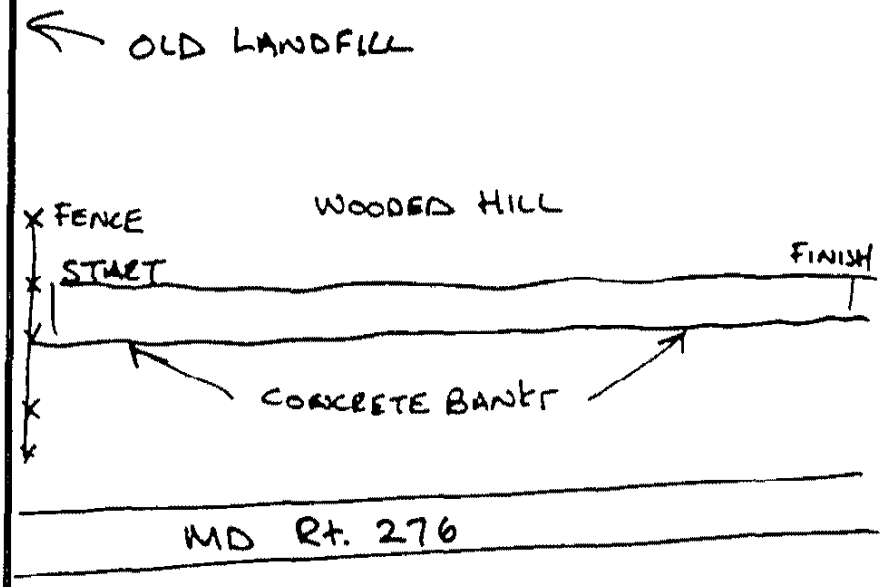
Has there been a heavy rain in the last 7 days? ☒ Yes ☐ No

Air Temperature 10 ° C

Other _____

SITE LOCATION/MAP

Draw a map of the site and indicate the areas sampled (or attach a photograph)



STREAM CHARACTERIZATION

Stream Subsystem
- ☒ Perennial ?
- ☐ Intermittent
- ☐ Tidal

Stream Type
- ☐ Coldwater
- ☒ Warmwater

Stream Origin
- ☐ Glacial
- ☐ Non-glacial montane
- ☐ Swamp and bog
- ☐ Spring-fed
- ☐ Mixture of origins
- ☒ Other STORM DRAIN ON BASE

Catchment Area _____ km²

PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET (BACK)

WATERSHED FEATURES

Predominant Surrounding Landuse
☒ Forest ☐ Commercial
☒ Field/Pasture ☐ Industrial
☐ Agricultural ☒ Other OLD LANDFILL
☐ Residential

Local Watershed NPS Pollution
☐ No evidence ☐ Some potential sources
☒ Obvious sources

Local Watershed Erosion
☐ None ☒ Moderate ☐ Heavy

RIPARIAN VEGETATION (18 meter buffer)

Indicate the dominant type and record the dominant species present
☒ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous

dominant species present TULIP POPLAR

INSTREAM FEATURES

Estimated Stream Width 1.0 m

Estimated Stream Depth 0.05 m

Surface Velocity _____ m/sec (at thalweg)

Estimated Reach Length 100 m

Canopy Cover
☒ Partly open ☐ Partly shaded ☐ Shaded

High Water Mark _____ m

Proportion of Reach Represented by Stream Morphology Types
☒ Riffle 20 % ☒ Run 70 %
☐ Pool 10 %

Channelized ☒ Yes ☐ No

Dam Present ☐ Yes ☐ No

AQUATIC VEGETATION

Indicate the dominant type and record the dominant species present
☐ Rooted emergent ☐ Rooted submergent ☐ Rooted floating ☐ Free Floating
☐ Floating Algae ☐ Attached Algae

dominant species present NONE PRESENT

Portion of the reach with aquatic vegetation 0 %

WATER QUALITY

Temperature 6.28 °C

Depth 0.11 m

Specific Conductance 0.065 mS

Salinity 0.03

Oxidation Reduction Potential: 155 mV

Dissolved Oxygen 11.11 mg/L

Percent Saturation 88.6

pH 7.4

Turbidity 18.7 NTU

Battery N/A V

WQ Instrument: Used Hydrolab Data Sonde 4

Water Odors
☒ Normal/None ☐ Sewage
☐ Petroleum ☐ Chemical
☐ Fishy ☐ Other _____

Water Surface Oils
☐ Slick ☐ Sheen ☐ Globs ☐ Flecks
☒ None ☐ Other _____

Turbidity (if not measured)
☐ Clear ☒ Slightly turbid ☐ Turbid
☐ Opaque ☐ Stained ☐ Other _____

SEDIMENT/ SUBSTRATE

Odors
☐ Normal ☐ Sewage ☐ Petroleum
☐ Chemical ☐ Anaerobic ☐ None
☐ Other _____

Oils
☐ Absent ☐ Slight ☐ Moderate ☐ Profuse

Deposits
☐ Sludge ☐ Sawdust ☐ Paper fiber ☒ Sand
☐ Relict shells ☒ Other IRON FLOC

Looking at stones which are not deeply embedded, are the undersides black in color?
☐ Yes ☒ No

INORGANIC SUBSTRATE COMPONENTS (should add up to 100%)			ORGANIC SUBSTRATE COMPONENTS (does not necessarily add up to 100%)		
Substrate Type	Diameter	% Composition in Sampling Reach	Substrate Type	Characteristic	% Composition in Sampling Area
Bedrock		0	Detritus	sticks, wood, coarse plant materials (CPOM)	70
Boulder	> 256 mm (10")	5			
Cobble	64-256 mm (2.5"-10")	15	Muck-Mud	black, very fine organic (FPOM)	30
Gravel	2-64 mm (0.1"-2.5")	20			
Sand	0.06-2mm (gritty)	40	Marl	grey, shell fragments	
Silt	0.004-0.06 mm	40			
Clay	< 0.004 mm (slick)	0			

HABITAT ASSESSMENT FIELD DATA - LOW GRADIENT STREAMS SHEET (FRONT)

STREAM NAME: West Branch Tributary (WBT)	LOCATION: BainbridgeOld Landfill. Along MD Rt.276	
STATION #_____ RIVERMILE_____	STREAM CLASS: First order	
LAT _____ LONG _____	RIVER BASIN: Susquehanna River	
STORET #	AGENCY: U.S Fish and Wildlife Service - Chesapeake Bay Field Office	
INVESTIGATORS: Fred Pinkney, Dan Murphy, and Peter McGowan		
FORM COMPLETED BY: Dan Murphy	DATE 12/11/98 TIME 10:00 (AM) PM	REASON FOR SURVEY: Ecological Risk Assessment followup investigation

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Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations: presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 (4) 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	(5) 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 15	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. Concrete on Rt. Bank looking downstream
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	(5) 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 (1) 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE 9 (LB)	Left Bank 10 (9)	8 7 6	5 4 3	2 1 0
SCORE 9 (RB)	Right Bank 10 (9)	8 7 6	5 4 3	2 1 0 — Concrete
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE 10 (LB)	Left Bank (10)	8 7 6	5 4 3	2 1 0
SCORE 1 (RB)	Right Bank 10	8 7 6	5 4 3	2 (1) 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 8 (LB)	Left Bank 10 9	(8) 7 6	5 4 3	2 1 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 (1) 0

Total Score 84

Appendix B

Benthos Data

Appendix B. Summary of benthic macroinvertebrates found in dip net samples collected from streams located at Bainbridge Naval Training Center and a Reference site.

ORDER	FAMILY	BBR[1]	HVB[2]	EBT[3]	WBT[4]
Ephemeroptera	Amelietidae		30	7	
Ephemeroptera	Baetidae	3	3		5
Ephemeroptera	Ephemerellidae	726	137	2	
Ephemeroptera	Heptagenidae	117	106	37	
Ephemeroptera	Isonychidae	9			
Ephemeroptera	Leptophlebidae	14			
Plecoptera	Capnidae	146	287	23	1
Plecoptera	Chloroperlidae	1	67		
Plecoptera	Inder. Instars		25		
Plecoptera	Nemouridae	61		4	
Plecoptera	Perlidae	23	2		
Plecoptera	Taeniopterygidae	16	24		
Trichoptera	Glossomatidae	26	13		
Trichoptera	Goeridae	2			
Trichoptera	Hydropsychidae	420	178	12	
Trichoptera	Hydroptilidae	3			
Trichoptera	Leptoceridae		6		
Trichoptera	Limnephilidae		3	4	3
Trichoptera	Philopotamidae	52	5	34	
Trichoptera	Polycentropodidae	5	16		
Trichoptera	Psychomyidae	2			
Trichoptera	Rhycophilidae	8			
Trichoptera	Venoidae	19	1		
Acarina	Hydracarina	3			
Amphipoda	Cambridae			1	
Amphipoda	Crangoncytidae		1	1	
Amphipoda	Gammaridae		192	17	1
Basommatophora	Ancylidae	7			
Basommatophora	Physidae		10		52
Basommatophora	Planorbidae		1		
Coleoptera	Dryopidae		1		
Coleoptera	Dytiscidae			1	6
Coleoptera	Elmidae	66	12		
Coleoptera	Gyrinidae		1		
Coleoptera	Hydrophilidae				1

Appendix B cont'd. Summary of benthic macroinvertebrates found in dip net samples collected from streams located at Bainbridge Naval Training Center and a Reference site.

ORDER	FAMILY	BBR[1]	HVB[2]	EBT[3]	WBT[4]
Coleoptera	Psephenidae	2	45	44	
Coleoptera	Ptilodactylidae	1			
Diptera	Ceratopogonidae	2	1		2
Diptera	Chironomidae	253	647	106	287
Diptera	Dolichopodidae				3
Diptera	Dixidae			7	
Diptera	Empididae	2			
Diptera	Ptychoteridae			1	10
Diptera	Tipulidae	252	18	13	9
Gordiidea	unknown	1			
Haplotaxida	Naididae		20	2	16
Haplotaxida	Tubificidae			2	
Haplotaxida	Unknown				1
Hemiptera	Notonectidae		1		
Isopoda	Asellidae				1
Lepidoptera	Pyralidae			1	
Lumbriculida	Lumbriculidae			1	1
Megaloptera	Corydalidae	5	8		1
Megaloptera	Sialidae	5	1	1	5
Odonata	Calopterygidae		4	2	2
Odonata	Cordulegastridae				3
Odonata	Gomphidae	3	13	1	
Odonata	Libellulidae				1
	TOTAL	2255	1879	324	411

1 BBR - Big Branch, Reference site
2 HVB - Happy Valley Branch
3 EBUT - East Branch Unnamed Tributary
4 WBT - West BranchUnnamed Tributary